

ON THE STRATIGRAPHICAL EVIDENCE AFFORDED BY THE TERTIARY
FOSSILS OF THE PENINSULA OF MARYLAND.

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The Tertiary deposits of Maryland have from time to time attracted the attention of investigators more or less eminent in their special lines of research, the results of whose observations, owing to the then imperfect state of American geological and paleontological science, only very gradually tended to unfold the true relations existing between the synchronous formations of the east-Atlantic and west-Atlantic countries.

Maclure, on the map accompanying his "Observations of the Geology of the United States" (1817), classed all the late superficial deposits of Maryland under the general term "Alluvial," which term was likewise applied to almost the entire border deposits of the Atlantic and Gulf slopes. In 1824 (J. A. N. S., vol. iv) Say described about forty species of fossil shells collected by Mr. Finch from the same state, but excepting some passing reflections on the nature of the deposit whence they were obtained, and on the great resemblance existing between some of the forms and forms still living on the coast, no special geological inferences were drawn from the collection. From a comparative examination of the contained fossils, Van Rensselaer ("Lectures on Geology," 1825, p. 261) subsequently referred the deposits in question to the Upper Marine formation, which view was concurred in by Morton in a paper read before the Academy of Natural Sciences of Philadelphia in June, 1828. In a previous paper ("Geological Observations on the Secondary, Tertiary, and Alluvial Formations," J. A. N. S., January, 1828), published conjointly by Vanuxem and Morton, no attempt was made to correlate the various divisions of the American and European Tertiary formations.

Conrad, who, more than any other American geologist, contributed to advance our knowledge of the geology and paleontology of this latest period, was the first to recognize the existence of at least three distinct post-Secondary formations in Maryland, the oldest of which he identified by a series of a few fossils found near Ft. Washington, on the Potomac, as belonging to the Eocene, and the newest, as exposed on the southeast extremity of the peninsula, to the Post-Pliocene (J. A. N. S., vol. vi, and Bulletin

of the National Institution, 1841). The intermediate deposits were classed as the Upper Marine, but subsequently under Lyell's designation of Miocene. Conrad's original observations were in general confirmed by his later researches, and the relations of at least a great portion of the Miocene of Maryland, as well as of almost the entire Atlantic slope, were clearly pointed out by Lyell in 1845 (Proc. of the Geolog. Soc., vol. iv, p. 547).

It is mainly in relation to this last formation that we wish to draw special attention, there being but little question concerning the original determination of the Eocene and Post-Pliocene (Pliocene?) deposits. That the great bulk of the deposits known as the Medial Tertiary of Maryland are not synchronous with the South Carolina deposits classed by Tuomey and Holmes as Pliocene, an assumed fact insisted upon by Conrad, and for which there appears to be no evidence, an examination of the following table of mollusca will clearly demonstrate :

Lamellibranchiata of the Medial Tertiary Formations of Maryland.

<i>Anomia ephippium</i> ,*	<i>Cardita</i> protracta,	<i>Leda</i> concentrica,
<i>Amphidesma</i> carinata,*	“ granulata,*	<i>Lima</i> papyria,
“ subovata,	<i>Cardium</i> laqueatum,	<i>Lepton</i> (?) mactroides,
<i>Arca</i> callipleura,	“ acutulaquea-	<i>Lucina</i> anodonta,*
(= <i>A. dipleur</i> ?),	tum,	(= <i>L. Americana</i>),
“ idonea,	“ craticuloides,	“ Foremani,
“ incile,*	“ leptopleura,	“ subobliqua,
“ subrostrata,	<i>Corbula</i> cuneata,*	“ subplana,
“ Marylandica,	“ idonea,	“ cribraria,*
“ triquetra,	“ elevata,	“ crenulata,*
“ centenaria,*	“ inequalis,*	“ contracta,*
“ improcera,*	<i>Crassatella</i> Marylandica,	“ divaricata,*
“ stilicidium,	“ turgidula,	<i>Mactra</i> incrassata,
<i>Artemis</i> acetabulum,*	“ melina,	“ ponderosa,
“ concentrica,	“ undulata,*	“ fragosa,
(= <i>A. elegans</i> ?),	<i>Cytherea</i> Sayana,*	“ subcuneata,
<i>Astarte</i> vicina,	“ albaria,*	“ delumbis,
“ cuneiformis,	(= <i>C. idonea</i>),	<i>Modiola</i> Ducatellii,
“ obruta,	“ Marylandica,	<i>Mya</i> producta,
“ perplana,	“ subnasuta,	<i>Mytilus</i> incurva,
“ exaltata,	<i>Isocardia</i> fraterna,	<i>Ostrea</i> Virginia,*
“ varians,	“ Markoei,	“ percrassa,*
“ distans,	<i>Leda</i> liciata,	<i>Panopaea</i> Americana,
“ planulata,	“ acuta,*	“ reflexa,*
“ undulata,*	“ (<i>Yoldia</i>) laevis,	“ porrecta,
<i>Cardita</i> arata,*	“ (<i>Nucula</i>) proxima,	(= <i>P. Goldfussi</i> ?)

Pecten Madisonius,	Perna maxillata,	Tellina lenis,
“ Humphreysii,	Petricola centenaria,*	Venus tetrica,
“ Jeffersonius,	Plicatula marginata,*	“ <i>Mortoni</i> ,
“ concentricus,	Pholadomya abrupta,*	“ alveata,
“ Clintonius,	Pholas ovalis,	“ inoceriformis,
“ septenarius,*	(= <i>P. costata</i> ?)*	“ stamineus,
Pectunculus parilis,*	<i>Saxicava rugosa</i> ,	“ tridacnoides,*
“ lentiformis,*	<i>Solen ensis</i> ,*	“ <i>violacea</i> ,*
“ subovatus,*	Tellina æquistriata,	“ Rileyi.*
	“ biplicata,*	

The species in *italics* are still living on the American coasts; those followed by an * are described by Tuomey and Holmes as occurring in the Pliocene formation of South Carolina.

[NOTE.—The preceding table has been compiled as accurately as possible from the various papers pertaining to the paleontology of the State, but owing to their number, and to the numerous publications in which they have been spread, it has proved impossible to collect them all, and no doubt some few species will be found occurring in the State which have escaped our notice. These will probably be very few in number, and will not materially affect the general conclusion. The following twenty-two species, mainly those described by Say from the collection of Mr. Finch (J. A. N. S., vol. iv), have no stated locality: *Arca centenaria*, *A. improcera*, *A. incile*, *Astarte distans*, *Crassatella undulata*, *Leda acuta*, *L. concentrica*, *L. proxima*, *L. lævis*, *Lucina contracta*, *L. divaricata*, *L. subobliqua*, *Panopæa reflexa*, *Pecten Jeffersonius*, *P. Clintonius*, *P. concentricus*, *P. septenarius*, *Pectunculus subovatus*, *Plicatula marginata*, *Tellina æquistriata*, *Venus deformis* (*tridacnoides*), and *V. Rileyi*.]

It will thus be seen, that of about one hundred species of bivalves, only thirty-six (36 per cent.) are common to about an equal number (105) from the South Carolina deposits; and further, that, whereas, of the preceding enumeration of Maryland mollusca only about *fifteen* per cent. are recent forms, no less than *forty* per cent. (or according to Tuomey and Holmes, nearly fifty per cent.) of the South Carolina Pliocene (Conrad's Miocene) bivalve mollusca are still living. There remains, therefore, no question regarding the relative ages of the two formations.

An examination of the fossiliferous strata exposed in sections at various points on the western shore of Chesapeake Bay, in

Anne Arundel and Calvert Counties, on the Patuxent River, near Benedict, and on the St. Mary's River, St. Mary's County, tend to show, moreover, that the series of deposits intermediate between the Eocene of Fort Washington and the Pliocene of the south-east extremity of the peninsula belong to two different periods of formation, an older and a newer; those belonging to the latter period being characterized by a fauna, the proportion of living forms in which is far in excess of that in the former. Sections of the newer deposits are exhibited in Calvert County, near Cove Point, on the Patuxent River, below Benedict, at about water level, on the same river, further north, in the deposits *above* the *Perna* beds, and more especially on the St. Mary's River, St. Mary's County. The older deposits are best shown in the oyster beds, rising a few feet above tide-water, at Fair Haven, Anne Arundel County (which point was considered by Conrad as the northern termination of the peninsular Miocene formation), in similar beds, also only a few feet above water level, at a point about twenty miles further south ("Colonel Blake's," of Conrad), in the sections exhibited by the Calvert Cliffs, and in the *Perna* beds on both banks of the Patuxent River. There is, further, strong, although not conclusive evidence, for considering the beds containing *Perna* *maxillata* and *Ostrea* *percrassa* as the lowest of the series.

The following tables exhibit as nearly as possible the distribution of Lamellibranchiata in the deposits of both periods, those of the newer being for convenience of comparison divided into the Patuxent and St. Mary's groups:

OLDER PERIOD.

1	<i>Area</i> <i>dipleura</i> .	11	<i>Corbula</i> <i>elevata</i> ,
	(= <i>A. calipleura</i> ?),	12	<i>Crassatella</i> <i>melina</i> ,
2	" <i>Marylandica</i> ,	13	" <i>turgidula</i> ,
3	" <i>subrostrata</i> ,	14	<i>Cytherea</i> <i>subnasuta</i> ,
4	" <i>triquetra</i> ,	15	<i>Isocardia</i> <i>Markoei</i> ,
5	<i>Artemis</i> <i>acetabulum</i> .	16	<i>Leda</i> <i>liciata</i> ,
6	<i>Astarte</i> <i>varians</i> ,	17	<i>Lima</i> <i>papyria</i> ,
7	" <i>exaltata</i> ,	18	<i>Lucina</i> <i>Foremani</i> ,
8	<i>Cardium</i> <i>eraticenloides</i> ,	19	" <i>subplana</i> ,
9	" <i>leptopleura</i> ,	20	" <i>crenulata</i> ,
10	<i>Corbula</i> <i>idonea</i> ,	21	<i>Mytilus</i> <i>incurva</i> ,

22	<i>Modiola Ducatellii</i> ,	29	<i>Perna maxillata</i> ,
23	<i>Ostrea pererassa</i> ,	30	<i>Pholas ovalis</i> ,
24	<i>Panopæa porrecta</i> (Goldfussi)		(= <i>P. costata</i> ?)
25	<i>Pecten Humphreysii</i> ,	31	<i>Tellina lenis</i> ,
26	“ <i>Madisonius</i> ,	32	<i>Venus alveata</i> ,
27	<i>Pectunculus parilis</i> ,	33	“ <i>staminea</i> ,
28	“ <i>lentiformis</i> ,	34	“ <i>Mortoni</i> ?

NEWER PERIOD.—I. PATUXENT GROUP.

1	<i>Anomia Conradi</i> ,	13	<i>Lucina Americana</i> , E.,
	(= <i>A. ephippium</i> ?).		(= <i>L. Floridana</i>).
2	<i>Arca idonea</i> , St. M.,	14	<i>Mactra incrassata</i> ,
3	<i>Artemis acetabulum</i> , St. M.,	15	<i>Mya producta</i> ,
4	<i>Astarte undulata</i> , St. M.	16	<i>Panopæa Americana</i> ,
5	<i>Cardita protracta</i> ,	17	“ <i>porrecta</i> (Gold-
6	<i>Cardium laqueatum</i> , St. M.,		fussi), St. M..
7	<i>Carbula idonea</i> , St. M., E.,	18	<i>Pecten Madisonius</i> , St. M., E..
8	<i>Crassatella Marylandica</i> , E.,	19	<i>Petricola centenaria</i> ,
9	<i>Cytherea Sayana</i> , St. M.,	20	<i>Pholas ovalis</i> ,
10	“ <i>Marylandica</i> ,		(= <i>P. costata</i> ?), St. M..
11	“ <i>albaria</i> ,	21	<i>Tellina biplicata</i> , E.,
12	<i>Isocardia fraterna</i> , St. M.,	22	<i>Venus Mortoni</i> ? St. M.

II. ST. MARY'S GROUP.

1	<i>Amphidesma carinata</i> ,†	14	<i>Corbula idonea</i> ,
2	“ <i>subovata</i> ,†	15	<i>Cytherea Sayana</i> ,
3	<i>Arca idonea</i> ,	16	“ (<i>Artemis</i>) <i>concen-</i>
4	“ <i>arata</i> ,†		<i>trica</i> ,†
5	“ <i>stilicidium</i> ,†		(= <i>A. elegans</i> ?).
6	<i>Artemis acetabulum</i> ,	17	<i>Isocardia fraterna</i> ,
7	<i>Astarte undulata</i> ,	18	<i>Lucina eribraria</i> ,†
8	“ <i>planulata</i> ,†	19*	<i>Mactra ponderosa</i> ,†
	(= <i>A. perplana</i> ?).	20	“ <i>subcuneata</i> ,†
9	“ <i>vicina</i> .†	21	“ <i>fragosa</i> ,†
10	<i>Cardita granulata</i> ,†	22	“ <i>delumbis</i> ,†
11	<i>Cardium laqueatum</i> ,	23	<i>Ostrea Virginica</i> ,†
12	<i>Corbula inequalis</i> ,†	24	<i>Panopæa porrecta</i> ,
13*	“ <i>cuneata</i> ,†	25	<i>Pecten Madisonius</i> ,

* *Corbula cuneata* and *Mactra ponderosa* are also found in the newer deposits of Calvert County, near Cove Point.

26	<i>Pholadomya abrupta</i> ,†	30	<i>Venus alveata</i> ,
27	<i>Pholas arcuata</i> ,	31	“ <i>Mortoni</i> ,
	(= <i>P. costata</i>),	32	“ <i>tetrica</i> ,†
28	<i>Saxicava rugosa</i> ,†	33	“ <i>mercenaria</i> ,†
29	<i>Solen ensis</i> ?†	34	“ <i>inoceriformis</i> .†

NOTE.—The italicized names represent species supposed to be identical with living forms; those (in the Patuxent group) followed by the letters St. M. and E., species common to St. Mary's and to Easton (Choptank River); and those (in the St. Mary's group) followed by a †, species peculiar to the locality.

A comparison of the foregoing lists will show at a glance, that of the thirty-four bivalves belonging to the older formations, at most only three (or 9 per cent.) are found to be living forms (*Pholas ovalis* [= *P. costata*?], *Venus alveata*, and *Venus Mortoni*), and that only six (18 per cent.) and seven (21 per cent.) are common respectively to the Patuxent and St. Mary's exposures, viz.:

To Patuxent.

To St. Mary's.

Artemis acetabulum,*
Corbula idonea,
Pholas ovalis,*
Panopæa porrecta,
Pecten Madisonius,
Venus Mortoni,

Artemis acetabulum,
Corbula idonea,
Pholas arcuata (= *costata*),
Panopæa porrecta,
Pecten Madisonius,
Venus Mortoni,
“ *alveata*.*

* There appears to be much confusion regarding the species of *Artemis* found fossil in the Atlantic tertiary deposits, and their relation to the forms now living on the Florida coast. In 1832 (“Fossil Shells of the Tertiary Formations,” p. 20) Conrad characterized the species *A. acetabulum*, which appears to have been until then confounded with the *A. concentrica*, Con., non Born (*A. discus*, Reeve, “Conchologia Iconica,” vol. vi, sp. 9), inhabiting the southern coast. No mention is there made of its being found also in a recent state, but subsequently, 1838 (“Fossils of the Medial Tertiary Formations,” p. 29), we find the following statement: “This fine species is very common in the localities named, and also occurs recent on the Florida coast.” In the list of shells inhabiting the Florida coast, prepared by the same author in 1846 (*A. J. Science*, 2d series, ii, p. 393), only two species of *Artemis* are catalogued, *A. elegans* and *A. concentrica*, and it therefore appears highly probable that the statement considering *A. acetabulum* also as a living form was founded on a misconception, the more especially, as an examination of the recent shells in the

Deducting two or three species that are also found at Easton, we still have left twenty-three (or 68 per cent. of the whole number) that are not found in the later deposits.

Museum of the Academy fails to reveal anything answering to Conrad's original description. This species appears moreover to be identical with the *Venus concentrica* described by Tuomey and Holmes in their work on the Pliocene fossils of South Carolina (1857, p. 82), and to which Conrad, apparently without good reason, applied the specific name of *intermedia* (*Dosinia* [*Artemis*] *intermedia*) in his check list of Miocene fossils (Proc. A. N. S., 1862, p. 575). The *A. acetabulum* is found fossil in the tertiary deposits of Maryland, Virginia, North Carolina and South Carolina, and must be carefully distinguished from the *A. concentrica* of Born, to which it bears only a distant resemblance. Another fossil species is probably the *A. elegans*, Con. (living on the Florida coast); one almost perfect specimen, which agrees in all essential respects with the recent forms, is in the Academy Miocene collections, but, unfortunately, the locality whence it was obtained is not given. In his account of the geology and organic remains of the peninsula of Maryland (1830, J. A. N. S., vol. vi, p. 212), Conrad mentions the *Cytherea* (*Artemis*) *concentrica*, Lam., as occurring in the St. Mary's exposure, but as subsequently ("Fossils of the Medial Tertiary," 1838, p. 30), it is distinctly stated that the same does *not* occur in the Miocene formation, it is highly probable that the original observation was erroneous. Certainly nothing corresponding either to the species in question or to *A. discus* is to be found in the Maryland Miocene collection of the Academy.

The common species inhabiting the southern coast is *not* the *A. concentrica* of Born, with which it has been frequently confounded, and to which it bears only a very slight resemblance, but the *A. discus* of Reeve (*loc. cit.*). A third species, the *A. (Dosinia) Floridana* Con., is unquestionably very closely allied to the last, from which it differs essentially only in the greater obliquity of the pallial sinus. In other respects it agrees with the figures and minute description of Born's species as given by Agassiz in his "*Iconographie des Coquilles Tertiaires*" (*Nouv. Mém. de la Société Helvétique*, 1845, vol. vii).

I am disposed to consider the various forms of *Venus alveata* and *V. latilirata* as mere varieties of one and the same species, a series of intermediate stages seeming to link them together. The *V. athleta* constituted by Conrad to embrace the *V. athleta* of Say, *V. latilirata* of Tuomey and Holmes, and the *V. paphia* of Lamarck, appears likewise to be nothing but a variety of the same form. The *V. alveata* is included by Stimpson among the living mollusca of the Atlantic coast (Smithsonian Check Lists, 1860), but this fact appears very doubtful in the opinion of Tryon ("American Marine Conchology," 1873, p. 160). It must be confessed, however, that there exists a very striking agreement between the fossil shell and specimens of the *V. paphia*, Linn., from St. Thomas, the main

On the other hand, the fossils of the newer deposits as exhibited in the sections on the west bank of the Patuxent show a very decided similarity to those of St. Mary's, for out of the twenty-two species of bivalves occurring there, no less than eleven (or just 50 per cent.) are also common to the last mentioned locality. There can, therefore, I believe, be no reasonable doubt that the deposits exposed on the Patuxent River immediately above the *Perna* beds constitute a direct continuation of the highly fossiliferous strata bordering both sides of the St. Mary's River. These last number among their fossil fauna also about thirty-four species of Lamellibranchs, the same number as is found in what we have designated as the older group, but of these thirty-four, about twenty-two (or, deducting *Corbula cuneata* and *Macra ponderosa*, twenty), or 65 per cent. are peculiar to the locality. Moreover, of the entire number, about nine (or 27 per cent.) are still living on the Atlantic coast. The dissimilarity of the two faunæ cannot fail to strike the least observant investigator, and Conrad has dwelt at some length upon this curious manifestation (A. J. Science, vol. xxviii, p. 282, and Bull. National Institution, 1841, p. 176). That paleontologist singularly enough (apparently not having made any exact numerical estimates either of the living forms, or of the forms found in one locality and not in the other) explains the differences as due solely to variable local conditions.¹

difference being a tendency on the part of the latter to lose the full solidity of its ribs some distance before they reach the posterior slope. The *V. alveata* exhibits a similar tendency, but not quite to the same extent.

I have been unable to discover any description of the *Pholas ovalis*, Con., nor is there any mention made of it either in the Miocene check list prepared by Conrad in 1862, (Proc. A. N. S.), or in that of Meek, of 1864 (Smithsonian Miscell. Collections). I have, therefore, only doubtfully referred it to *P. costata*.

¹ Thus he states (A. J. S. *loc. cit.*): "If our coast were now suddenly elevated, we should find spots where the shells would consist chiefly of an immense number of *Modiola demissa* mixed with *Littorina littorea* and *Melampus bidentatus*; these are found on the margin of the lagoons at high water mark, the *Modiola* imbedded in a tenacious soil. At a little distance would be found *Venus mercenaria*, *Mya arenaria*, *Solen ensis*, *Solecurtus Caribæus*; among these would be *Ostrea Virginiana*, *Fusus cinereus*, and a few of *Pecten concentricus*. Such is the group existing on the sandy shore of the Estuaries. Hard by, would be a vast deposit of oyster shells with *Echinus*, and immense masses of *Serpula*. These live on the bottom of the lagoons, which is composed of a mixture of sand and

This interpretation might very satisfactorily account for the phenomenon as far as generic distribution alone is concerned, and, indeed, it would even hold good in its bearings on a limited number of species, but it would hardly apply to a case such as the present one, where the specific dissimilarity is so vast in such a comparatively very limited geographical extent.

Now, if the supposition that the deposits in question were deposited at two different periods be a correct one, and paleontological evidence goes far to prove that they were, we should naturally expect to find also some direct stratigraphical evidence afforded by the superposition of the strata themselves.¹ The following section was obtained by Conrad at a point on the Ches-

mud. Then would be found another group of shells which live only in deep water, the *Astarte lunulata*, *Nucula limatula*, *N. proxima*, *Cardita borealis*, *Pholas costata*, in company with great numbers of *Mytili*. This deposit we should recognize as having been formed in harbors, like those of Newport and Charleston. . . . "

It will be observed, that in the above conception Conrad has confined himself entirely to generic and not specific distribution.

¹ It may as well be remarked, that, although in the foregoing examination of the molluscan fauna I have dwelt exclusively upon the *Lamelli-branchiata*, the *Gasteropoda* offer equal, if not greater support to the general conclusion arrived at. On comparing the lists of geographical distribution given by Conrad in the Bulletin of the National Institution (pp. 181-7), it will be seen, that not a *single* recent form occurs among the eighteen enumerated from the Calvert cliffs at "Hance's;" and further, that only two species, *Voluta mutabilis* and *V. solitaria*, are common to the forty-two found at St. Mary's. Of these last eight (or 19 per cent.) were considered by Conrad to be recent forms :

Buccinum trivittatum,	Natica duplicata,
" lunatum,	Dentalium dentalis,
" quadratum,	Fusus cinereus,
Natica heros,	Scalaria clathrus.

Nearly all the species found on the west bank of the Patuxent also occur at St. Mary's, and the same can be said of those collected in Calvert county near Cove point the southern extremity. Singularly enough, that although three species of *Turritella*—*T. indenta*, *T. exaltata*, and *T. perlaqueata*—were collected from Calvert cliffs in the upper portion of the county, none of them appear to have been found near Cove Point, where "vast quantities" of a new species, *T. plebeia*, "the common species of St. Mary's River" (loc. cit. p. 182), appear suddenly to make their appearance.

peake, near "Beckett's," about twenty-eight miles south of Fair Haven:

Feet in Thickness.

5	Sand, without shells.
3	Sand, with innumerable shells.
20	Mingled sand and clay, without fossils, or very rare.
3	Same as below, less numerous.
4	Sand and clay, with a group of shells like that at Hance's.

The shells obtained at Hance's, about four miles further north, were the following:

Bivalves.

Astarte varians,
 " exaltata,
 Artemis acetabulum,
 Arca subrostrata,
 " dipleura,
 Cytherea subnasuta,
 Cardium leptopleura,
 Crassatella melina,
 Corbula idonea,
 " elevata,

Bivalves.

Isocardia Markoéi,
 Lima papyria,
 Lucina Foremani,
 " subplanata,
 " crenulata,
 Pectunculus lentiformis,
 Venus latilirata,
 " Mortoni?
 " staminea.

Univalves.

Bonellia lineata,
 Cancellaria biplicifera,
 " engonata,
 Dentalium thalloides,
 Fissurella Marylandica,
 Voluta mutabilis,
 Infundibulum perarmatum,
 Marginella perexigua,
 Pleurotoma Marylandica,

Univalves.

Pleurotoma bellaerenata,
 Searia pachypleura,
 Solarium trilineatum,
 Sigaretus fragilis,
 Trochus peralveatus,
 Turritella indenta,
 " exaltata,
 " perlaqueata,
 Voluta solitaria.

It will be at once noticed that in addition to the lowest fossiliferous stratum, extending to about seven feet above water level, a second highly fossiliferous one manifests itself at a height of about twenty-seven feet, in which were recognized among other shells *Artemis acetabulum* and *Pecten Madisonius*. The mineral character of this upper deposit is described by Conrad as being a "quartzose sand, very incoherent," which is exactly what we meet with in the arenaceous deposits on the west bank of the Patuxent River, near Benedict, and which we have identified as equivalents of the St. Mary's deposits. They are described by Conrad as being composed of an "arenaceous, fossiliferous stratum," the sand of which is "quartzose and incoherent" (B. N. I., p. 185).

We have thus exposed in one section two highly fossiliferous strata, the upper of which shows a very decided analogy to what we have designated as the newer group, and the lower of which assumes a distinct personality for reason of its position, and the paleontological characters impressed upon it. Proceeding from this point southeastward, and therefore in the general direction of the dip of the beds, we should naturally expect to meet a point where our upper stratum, or its equivalent, would descend nearer to the level of the Bay, and in fact we do find just such a point near Cove Point, where "the group most characteristic of these tertiary deposits, imbedded in sand," descends to a height only about fifteen feet above water mark (B. N. I., p. 183). The fossils found here are also nearly all found at St. Mary's, and they are, moreover, "highly ferruginous, as much so as many of the crag fossils of Great Britain, which they greatly resemble, also, in other respects" (Conrad, loc. cit.). On the St. Mary's River, the southeasternmost extension of the formation, the same deposit sinks almost to water level, as might well be expected on following the general direction of the dip. Here, the Pliocene deposits, well characterized by their fossils, make their appearance.

On proceeding from our first point almost due northwards, and therefore at a considerable angle to the line of strike, we meet with just the reverse phenomena met with on our southern journey. At Fair Haven, where Conrad obtained the following section,

Feet in Thickness.

50	Whitish Clay.
.....	
	Bones of Cetacea.
3	Clay, with siliceous casts of marine shells and fragments of bones.
5	Clay, with <i>Ostrea percrassa</i> , <i>Pecten Humphreysii</i> .

the highly fossiliferous stratum found at water mark, at Beckett's, is probably represented by a bed of clay three feet in thickness, commencing at a height of five feet, and which contains "great numbers of black, water-worn, siliceous casts of small shells, chiefly *Turritella*, the species not yet determined." Below this an entirely new deposit now makes its appearance, a bed of clay of five feet thickness, characterized by *Ostrea percrassa* and *Pecten Humphreysii*. This last, therefore, probably represents the most ancient post-Eocene deposit exhibited on the Chesapeake. *Ostrea percrassa* and *Pecten Humphreysii* were also found by Conrad at Huntingtown, Calvert County, where in a "depression or small valley" a race-way had been excavated through the fossiliferous "marls." The lowest member of the section was "quartzose sand, with casts of *Perna maxillata*." On the east bank of the Patuxent River, moreover, near the mouth of St. Leonard's Creek, Conrad observed innumerable casts of *Perna maxillata* imbedded in a stratum of fine siliceous sand, and resting on the fragmentary rock considered by him as the "foundation of the peninsula" (B. N. I., p. 184).

We should naturally look for some deposit contemporaneous with that occurring on the west bank of the Patuxent, at some point northeast of that locality where a section may present itself. This we find at Easton, on the Choptank, where the molluscan fossil fauna corresponds very closely with that observed on the former river. The deposits of the older period, on the other hand, reappear in Cumberland County, New Jersey, in the "Miocene marl" of Shiloh, containing the following assemblage of fossils (Cook, "Geology of New Jersey," 1868, p. 297):

Bivalves.

<i>Ostrea Mauricensis</i> ,	<i>Astarte Thomasii</i> ,
“ <i>percrassa</i> ,	<i>Venus Ducatellii</i> ,
<i>Plicatula densata</i> ,	<i>Periploma alta</i> ,
<i>Carditamera aculeata</i> ,	<i>Corbula elevata</i> ,
“ <i>arata</i> ,	<i>Saxicava myæformis</i> .
<i>Crassatella melina</i> ,	

Four species of the above are also found in Maryland, three of which, *Ostrea percrassa*, *Crassatella melina*, and *Corbula elevata*, are found, I believe, exclusively in the deposits designated as those of the older period. None are recent forms.

The small percentage of living forms occurring in the “older deposits,” as compared with that of the “newer,” leaves little doubt for the inference that the deposits in question were formed at two different periods, the latest of which clearly belongs to the Miocene. A comparative examination of some of the peculiar fossil forms of the older deposits, together with the extremely low percentage of living forms, seems to indicate an age more nearly Oligocene than Miocene, although perhaps not a single Eocene species is represented. This last fact need not surprise us, however, as the relationship of the Oligocene to the Miocene appears to be greater in almost all the localities of its representation than to the Eocene. The Eocene, moreover, of Maryland is represented only by a very limited number of fossils, and Conrad, himself, has called attention to the fact, that there appears to exist a greater amount of difference between the Eocene and Miocene formations than obtains between the Secondary and Tertiary, or between the Devonian and Carboniferous systems (B. N. I., p. 177). The following comparison may serve to throw some light upon the relative age of the deposits in question :

***Perna maxillata*, Lam.**

This species agrees thoroughly with the figure and description of the same given by Goldfuss in the “*Pectrefacta Germaniæ*” (vol. ii, p. 106), and to which the locality Weinheim (Oligocene) is assigned. The sub-Apennine species, formerly classed under the same name, is considered by Deshayes to be distinct, and he has applied to it the specific name of *Soldanii* (Lamarek, “*Animaux sans Vertébrés*,” 2d ed., vol. vii, p. 79). A second species of *Perna*, the *P. Sandbergeri*, Desh., also occurs in the Oligocene locality of

Weinheim (Sandberger, "*Conchylien des Mainzer Tertiärbeckens*," p. 367).

***Mytilus incurva*, Conr.**

This large species of *Mytilus* may perhaps be taken as the representative of *M. Haidingeri*, Hürnes ("*Fossilen Mollusken des Tertiärbeckens von Wien*," *Abhand. d. k. k. geolog. Reichsanstalt*, iv, p. 356), found both in the Oligocene (Eggenburg) and Miocene divisions of the Vienna basin. Rolle (*Sitzungsberichte d. k. Akad. d. Wissenschaften*, 1859, p. 64) and Sandberger consider the *M. Haidingeri* as the equivalent of *M. Faujasi*, Brongn., occurring at numerous Oligocene localities of the Vienna and Mentz basins.

***Isocardia Markoei*, Conr.**

This *Isocardia* is, it appears to me, erroneously referred by Hürnes (*loc. cit.*, p. 165) to the *I. cor*, L., from which it is very readily distinguished by its relatively much greater height, and greater development of the umbones. It is a singular fact, that this species of *Isocardia* was followed in the later period by the *I. fraterna*,* Say, which is barely distinguishable from fossil examples of the *I. cor* from Astigiana and Sicily.

It is worthy of remark, that Rolle (*loc. cit.*, p. 81), as early as 1859, only four years after Beyrich first applied the term Oligocene to some of the middle Tertiary deposits of northern Germany, hinted at the possible existence of the same formation on the banks of the Patuxent, his conclusions being drawn from an examination, among other fossils, of specimens of *Lucina anodonta*, Say, *Arca idonea*, Conr., and *Cardium laqueatum*, Conr.

* On comparison with specimens from the English Crag this species will be found to differ very broadly from the *I. (Cyprina) rustica* of Sowerby, with which it has been confounded.